

Ecosystem Approach to Protecting, Recovering and Sustainably Using Marine Biodiversity

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Marine
Conservation
Biology
Institute





When we try to pick
anything out by itself,
we find it hitched to
everything else in the
universe

John Muir
1838-1914



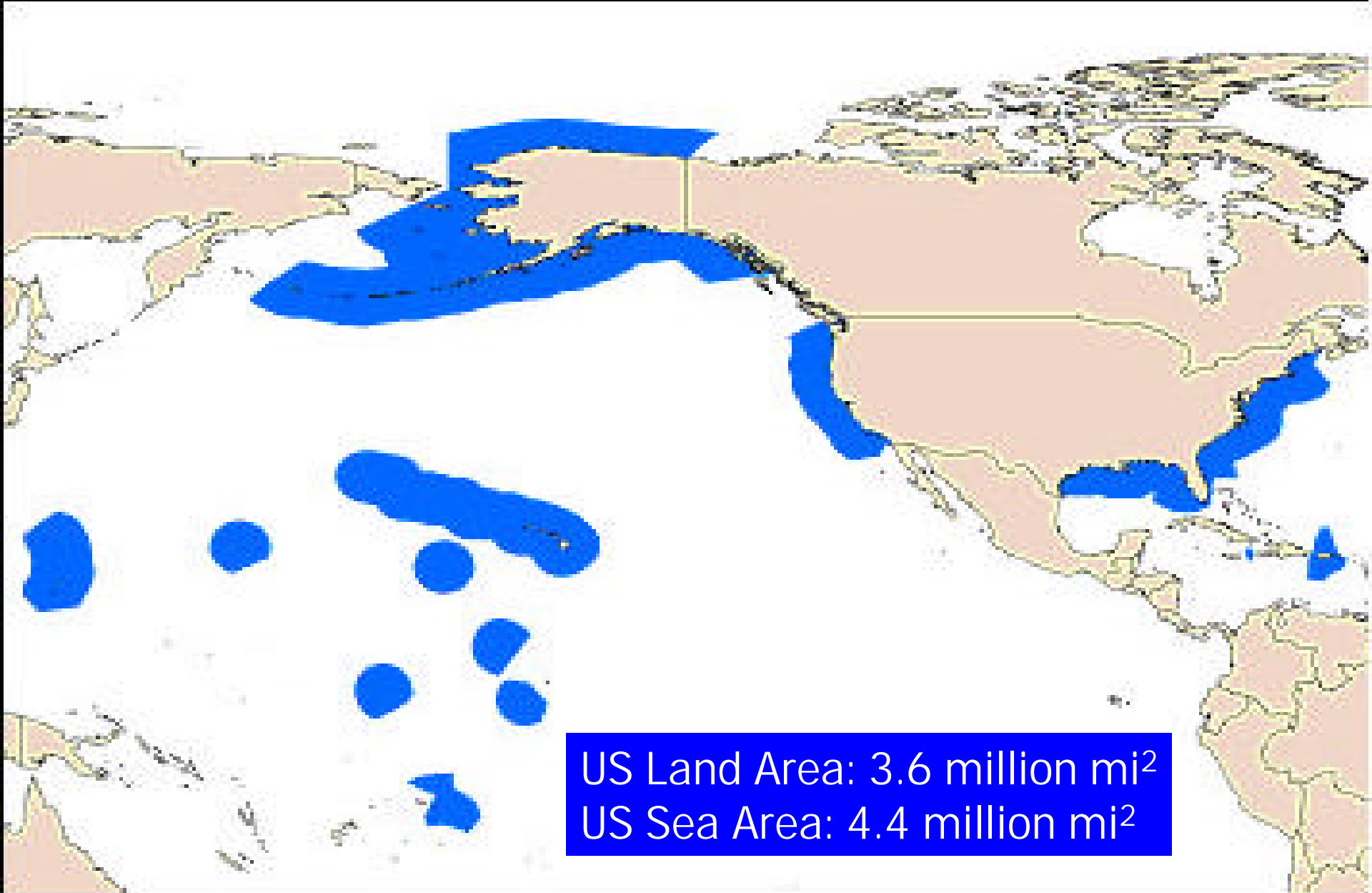
The most dangerous
phrase in the
language is:
"We've always done it
this way"

Admiral Grace Hopper
1906-1992

Please Fasten Your Seatbelts for:
THE ECOSYSTEM APPROACH



US Ocean Jurisdiction



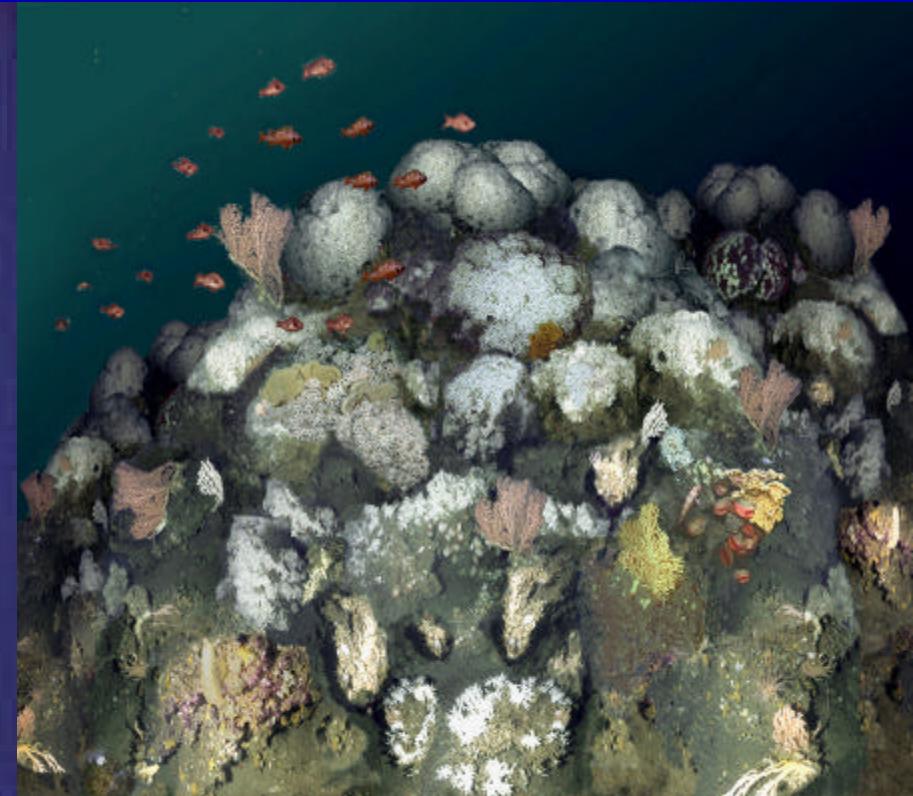


Alarming Ecosystem-level Indicators

- Megafauna are vanishing
- Habitat-formers are vanishing



Scott Eckert, Duke University



Jan Helge Fosså, IMR Norway

Oceanic whitetip shark populations are down **99.7%**
in Gulf of Mexico since longlining began in 1950s
J. Baum & R. Myers (2004). *Ecology Letters* 7: 135-145



Trawling Has Obliterated Seafloor Structure-formers, *Oculina* Banks, Florida



R. Grant Gilmore, HBOI



Lance Horn, NURC UNC-W

Many Young Hawaiian Monk Seals Starve



Seeing These Symptoms, What's Your Diagnosis, Doctors?

- Serial decline of commercially fished species (inshore to offshore, shallow to deep, large to small, desirable to undesirable)
- Decreasing average trophic level of catch
- Declining long-lived nontarget species (elasmobranchs, sea turtles, seabirds, marine mammals)
- Increasing benthic habitat damage
- Explosions of heretofore less common species (e.g. algal blooms and jellyfishes)



A Pertinent Quote from *Collapse* by Jared Diamond (2005)

Any people can fall into the trap of overexploiting environmental resources, because the resources initially seem inexhaustibly abundant; signs of their incipient depletion become masked by normal fluctuations in resource levels between years or decades; it is difficult to get people to agree on exercising restraint in harvesting a shared resource (the so-called tragedy of the commons) and the complexity of ecosystems often makes the consequences of some human-caused perturbation impossible to predict even for a professional ecologist.

3 Evolutionary Stages in Conservation

Utilitarian
(Focus on use)



Protect species
in danger of
extinction



Protect & recover
biological diversity
and integrity

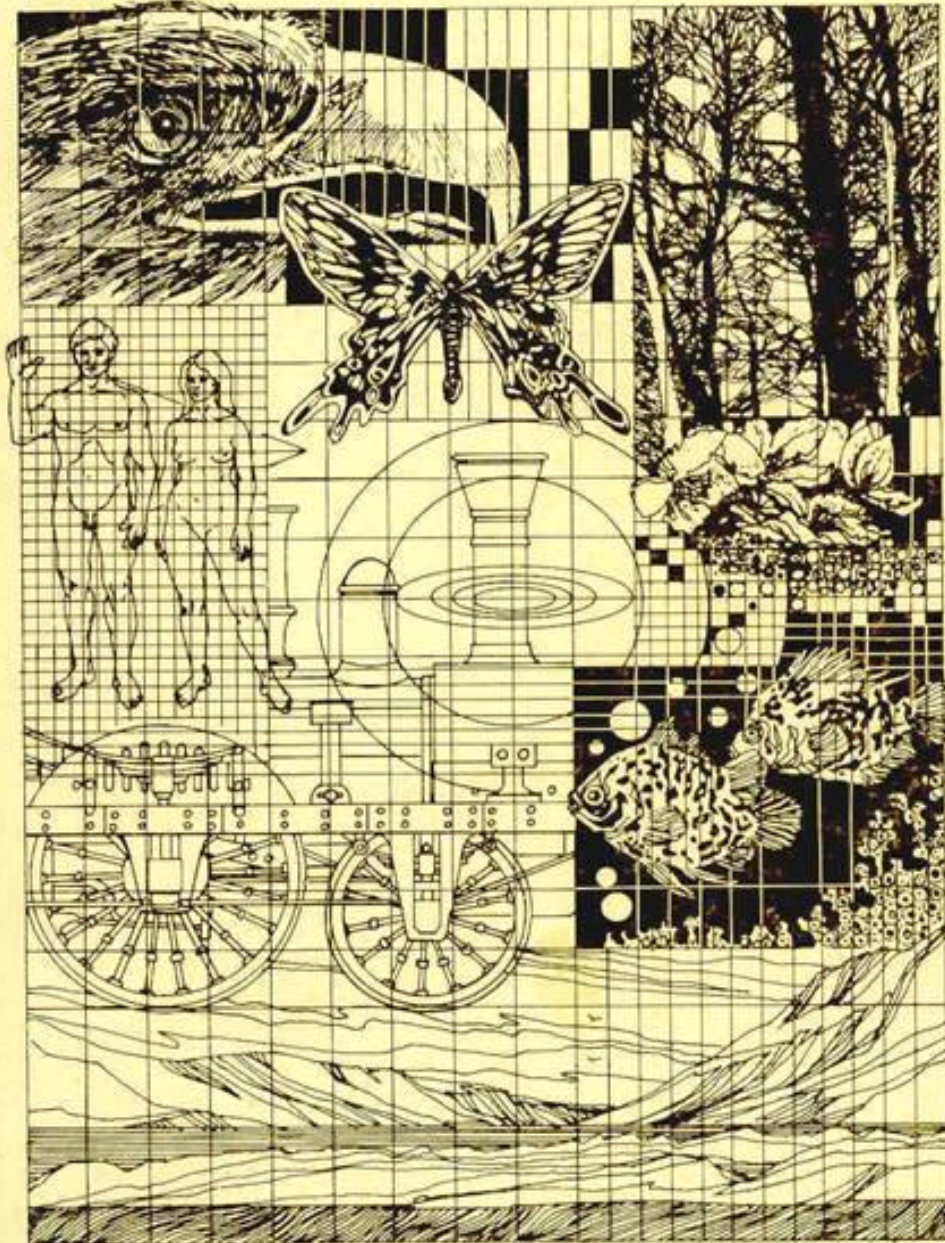




Marine
conservation
thinking
has changed
dramatically
since I entered
federal service
in ocean policy
28 years ago

Environmental Quality

the eleventh annual report of the council on environmental quality



E.A. Norse & R.E.
McManus (1980)
Biological diversity
in
*11th Annual Report
of the Council on
Environmental
Quality*

CONSERVING
BIOLOGICAL DIVERSITY
IN OUR NATIONAL FORESTS



THE WILDERNESS SOCIETY

E.A. Norse,
K.L. Rosenbaum,
D.S. Wilcove,
B.A. Wilcox,
W.H. Romme,
D.W. Johnston &
M.L. Stout (1986)

*Conserving Biological
Diversity in Our
National Forests*

ANCIENT FORESTS OF THE PACIFIC NORTHWEST

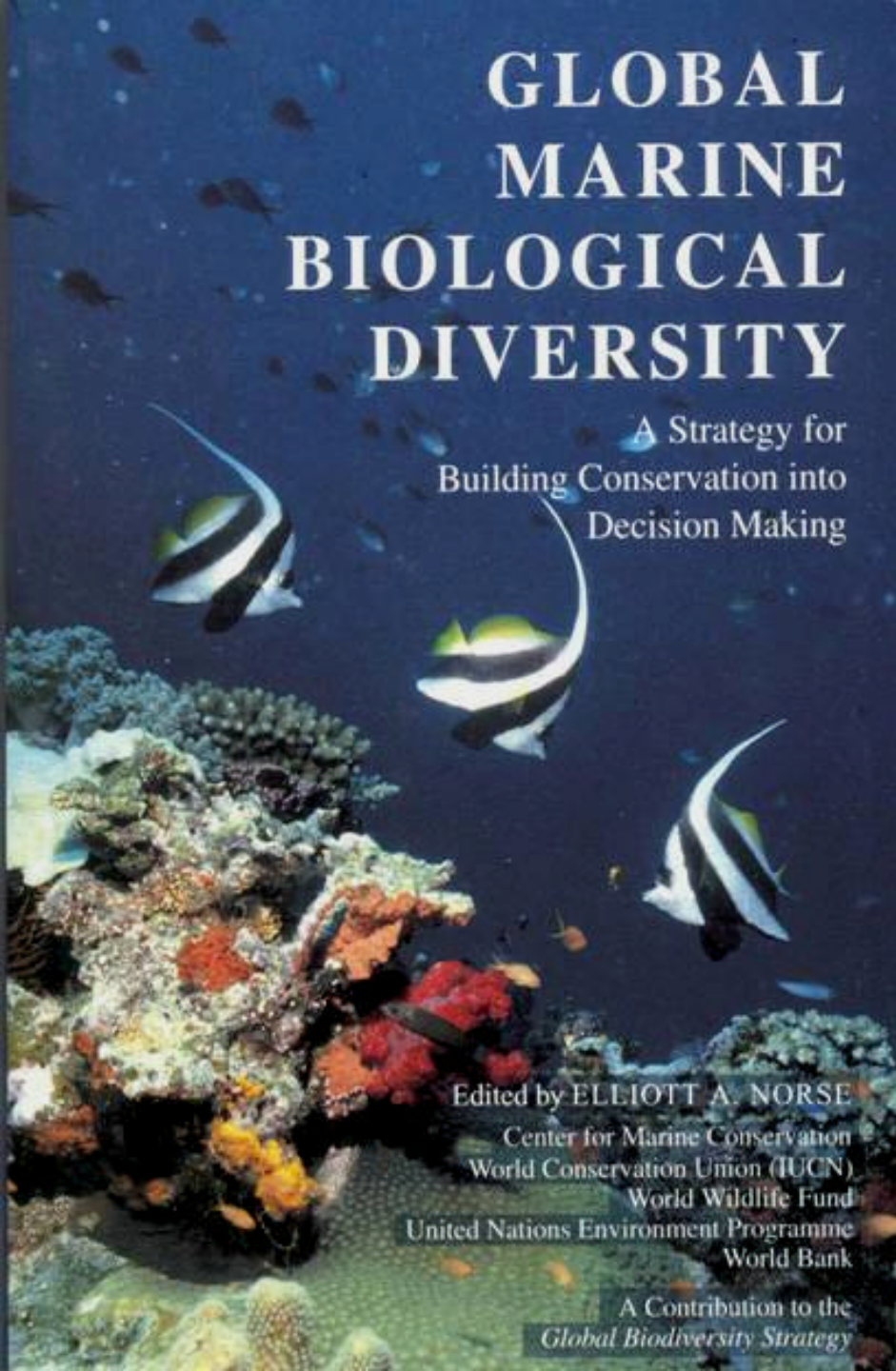


THE
WILDERNESS
SOCIETY

The
grandeur,
complexity,
diversity,
and
impending
destruction
of a fragile
and vital
ecosystem

E.A. Norse (1990)

*Ancient Forests
of the Pacific
Northwest*



GLOBAL MARINE BIOLOGICAL DIVERSITY

A Strategy for
Building Conservation into
Decision Making

Edited by ELLIOTT A. NORSE

Center for Marine Conservation
World Conservation Union (IUCN)
World Wildlife Fund
United Nations Environment Programme
World Bank

A Contribution to the
Global Biodiversity Strategy

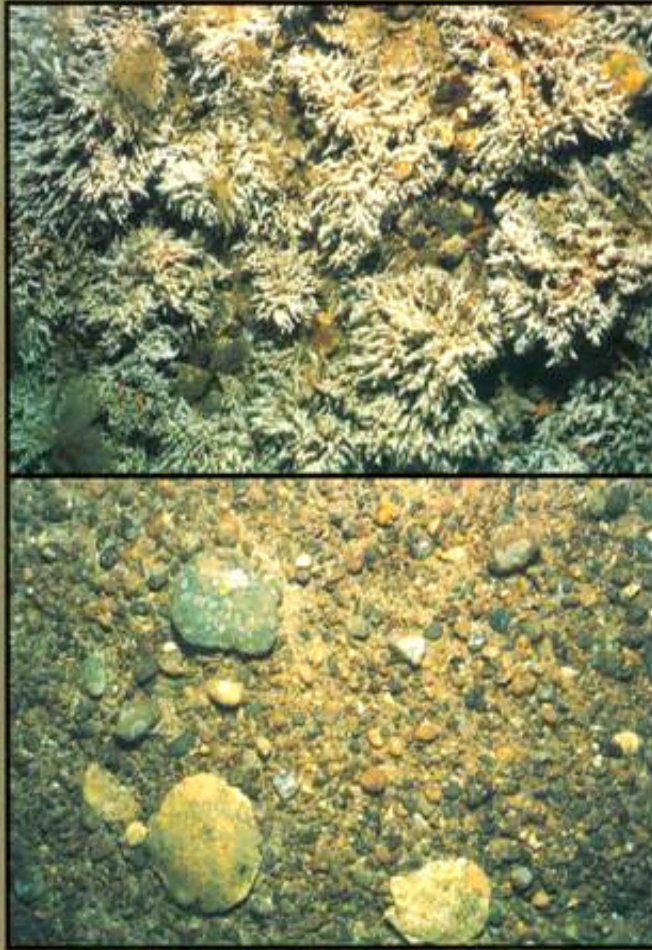
E.A. Norse, ed. (1993)

*Global Marine Biological
Diversity:*

*A Strategy for Building
Conservation into
Decision Making*

Conservation Biology

Volume 12 • No. 6 • December 1998



The Journal of the Society for Conservation Biology

Blackwell Science, Inc.

ISSN 0888-8892

Special Section: Effects of
Mobile Fishing Gear
on Marine Benthos

L. Watling &
E.A. Norse (1998)

Disturbance of the
seabed by mobile
fishing gear:

A comparison with
forest clearcutting

*Conservation
Biology* 12(6):
1180-1197

Marine Conservation Biology

THE SCIENCE OF MAINTAINING THE SEA'S BIODIVERSITY



Edited by Elliott A. Norse and Larry B. Crowder

Foreword by Michael E. Soulé

Marine Conservation Biology Institute

E.A. Norse &
L.B. Crowder, eds.
(2005)

*Marine
Conservation
Biology:
The Science of
Maintaining the
Sea's Biodiversity*

Stock Assessments Fail to Address That:

- Marine animals live in habitats; you can't manage them without maintaining *habitat* composition, structure and function
- Marine species interact, so they need to be managed as components of *interaction* webs
- Habitats are patchy and marine populations have metapopulation dynamics, so maintaining *connectivity* is crucial
- Different age classes make very unequal contributions to *population resilience*

Fisheries Biology Underestimates Importance of Behavioral Ecology



F. Coleman & S. Williams
(2002) *Trends in Ecology
& Evolution* 17: 40-44
found that red groupers
keep reef rock clear of
sediment

Overfishing such “*ecosystem engineers*”
could inhibit recruitment of corals and sponges

Fisheries Biology Underestimates Food Web (Especially Top-down) Ecosystem Effects

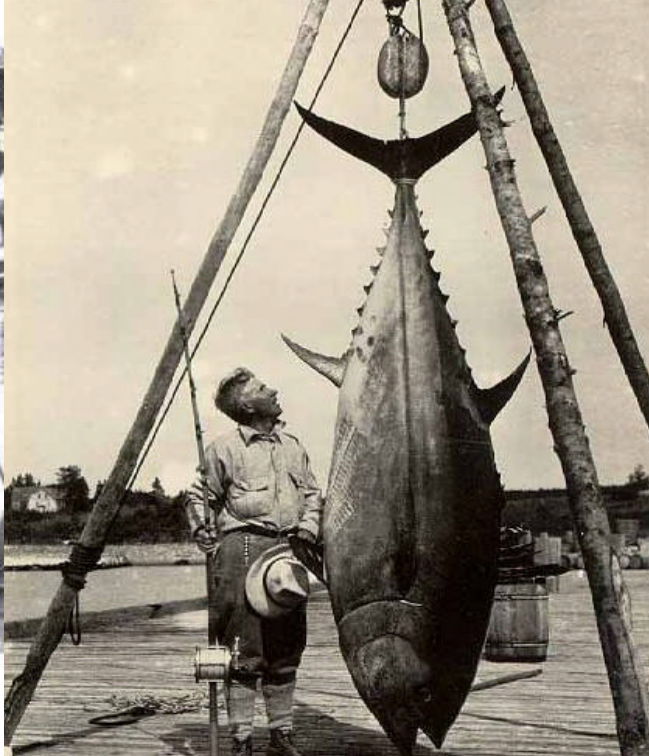


Of the 500 most recent citations
of R.T. Paine (1966)

Food web complexity and
species diversity

American Naturalist 100: 65-75

only 5 are in fisheries journals



Fisheries Biology Has Overlooked Shifting Baselines



The First Fatal Blow to the Old Paradigm



Larkin, P.A. (1977). An epitaph for the concept of maximum sustained yield

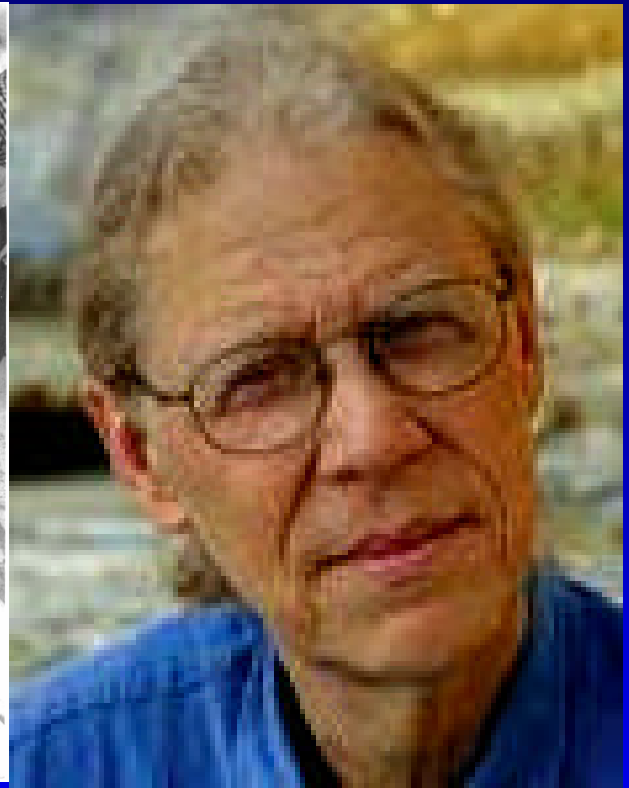
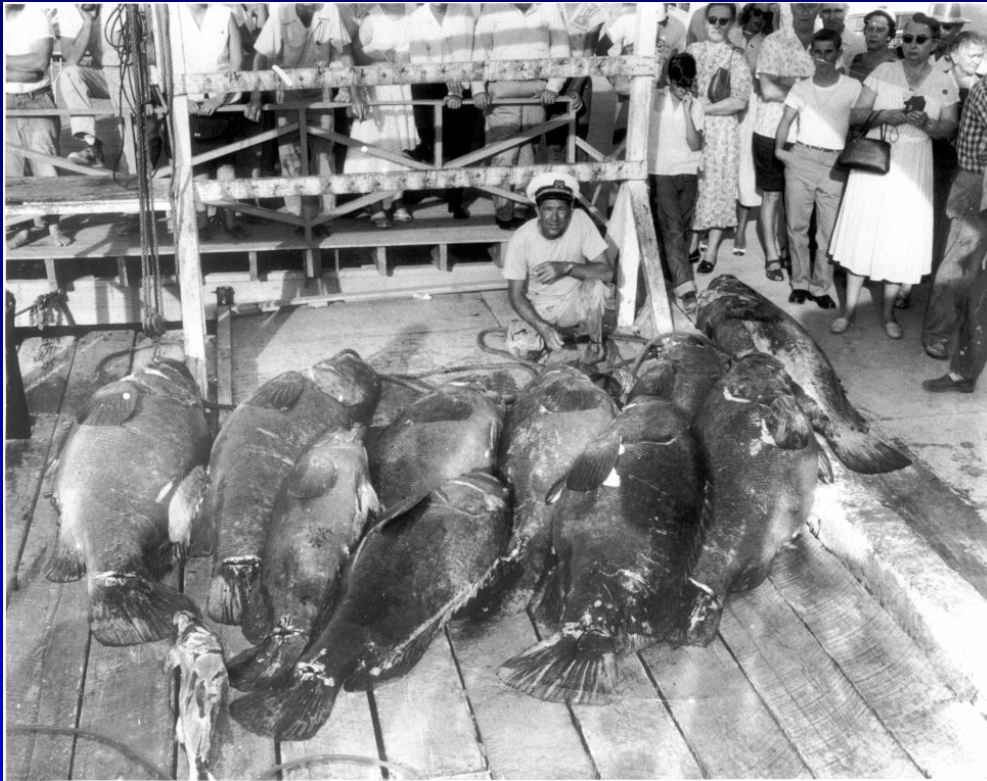
Transactions of the American Fisheries Society
106 (1): 1–11

Another Fatal Blow to the Old Paradigm



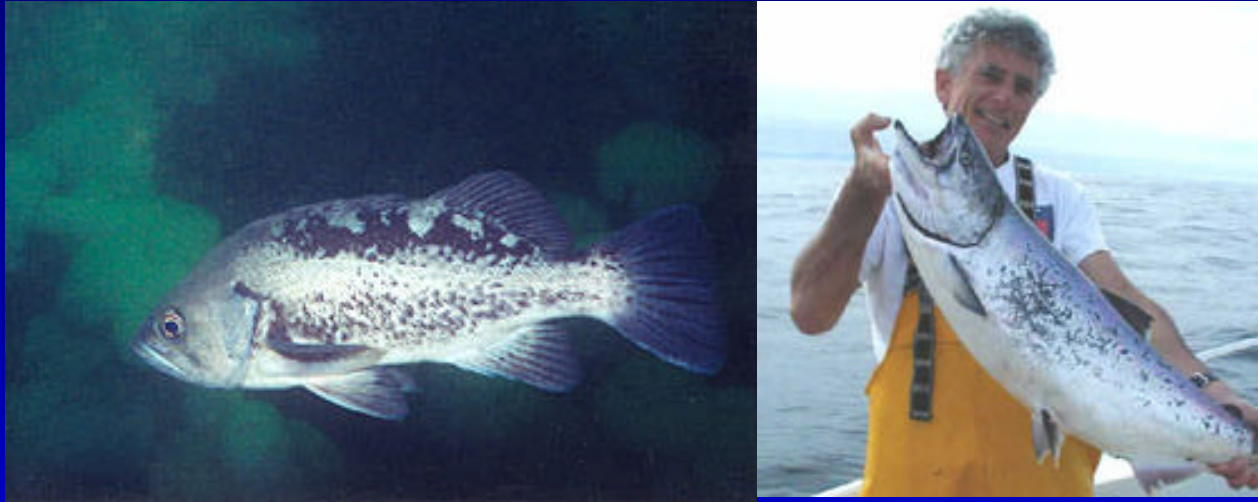
D. Pauly, V. Christensen, J. Dalsgaard, R. Froese and F. Torres (1998). Fishing down marine food webs. *Science* 279: 860-863

Yet Another Fatal Blow to the Old Paradigm



J. Jackson and 18 co-authors (2001)
Historical overfishing and the recent
collapse of coastal ecosystems
Science 293: 629-638

The Final Fatal Blows to the Old Paradigm



S.A. Berkeley, C. Chapman & S.M. Sogard (2004)
Maternal age as a determinant of larval growth and
survival in a marine fish, *Sebastes melanops*.

Ecology 85: 1258-1264

S.A. Berkeley, M.A. Hixon, R.J. Larson & M.S. Love (2004)
Fisheries sustainability via protection of age structure
and spatial distribution of fish populations.

Fisheries 29(8): 23-32

DUMB AND DUMBER



Industry Still Presses NOAA
to Make Appalling Choices!

Dumb: Pacific Fishery Management Council is considering allowing commercial krill fishery

Dumber: Western Pacific Fishery Management Council is pushing to reopen spiny lobster fishery in NW Hawaiian Islands Sanctuary

Hey... I eat krill!



Hey... I eat spiny lobsters!





Growl!

How You Must Feel

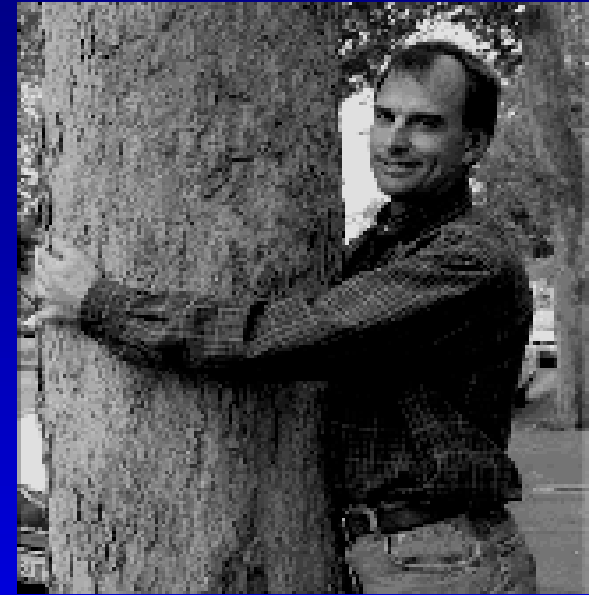
***Being in the middle
is so hard!***



I'll lose my job!



**NOAA
Fisheries**



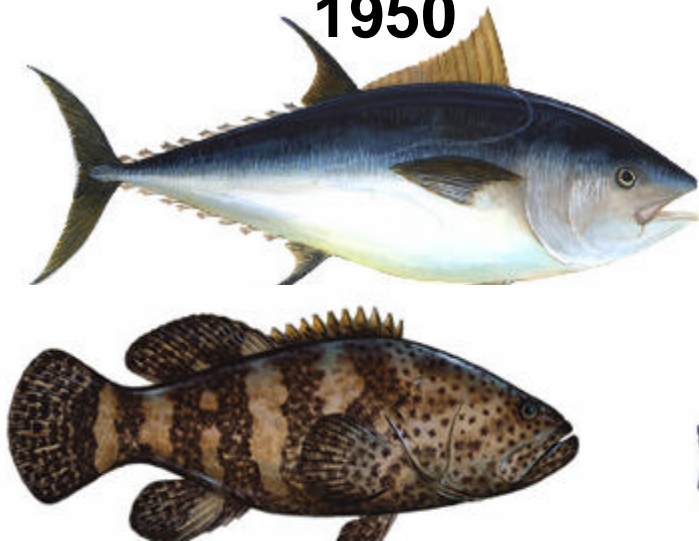
I'll lose my planet!



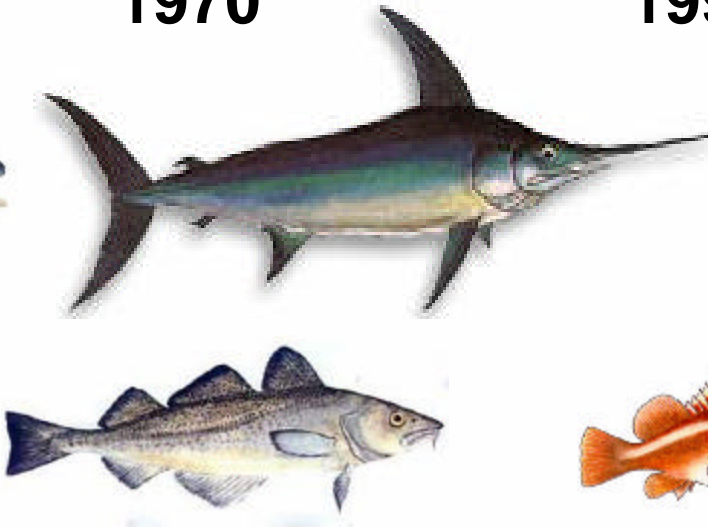
The Truth is:

- NOAA Fisheries has had a definite leaning
- Our marine species, ecosystems and fisheries are in deep trouble
- It's *not* too late to change things
- Doing so will benefit our oceans and NOAA
- I'm here to help

1950



1970



1990



2010



Ocean Management Systems Change

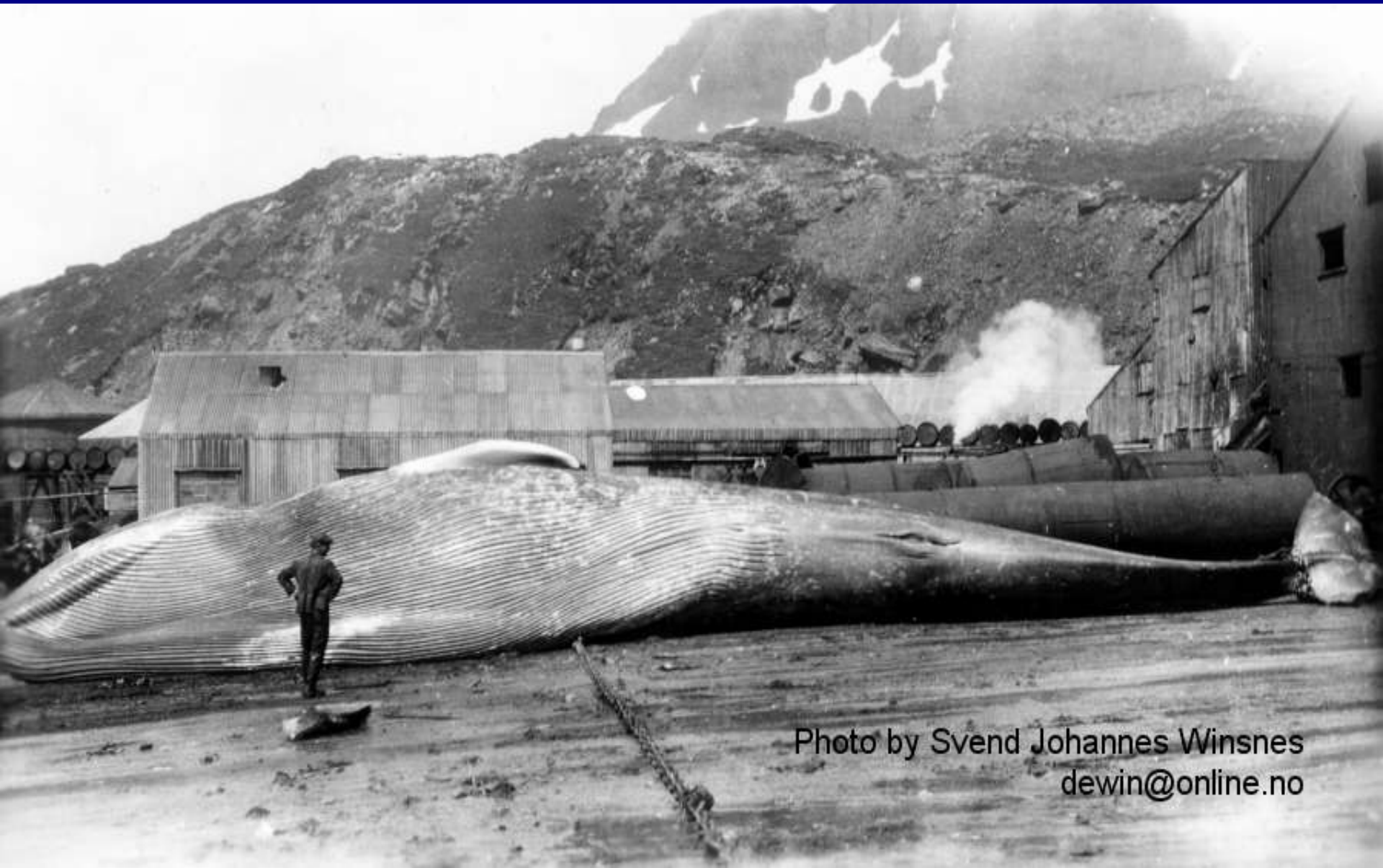


Photo by Svend Johannes Winsnes
dewin@online.no

Systems Change Because *We* Change Them





Science progresses
one death at a time

Attributed to
Niels Bohr
1885-1962



Reintroducing the Keystone Predator



Complex Systems

Definition: systems with multiple components whose interactions produce system behaviors that cannot always be predicted from knowing how individual components work

Examples: stock markets, baseball playoff races, presidential elections, *marine ecosystems*

Microsoft Corporation, 1978

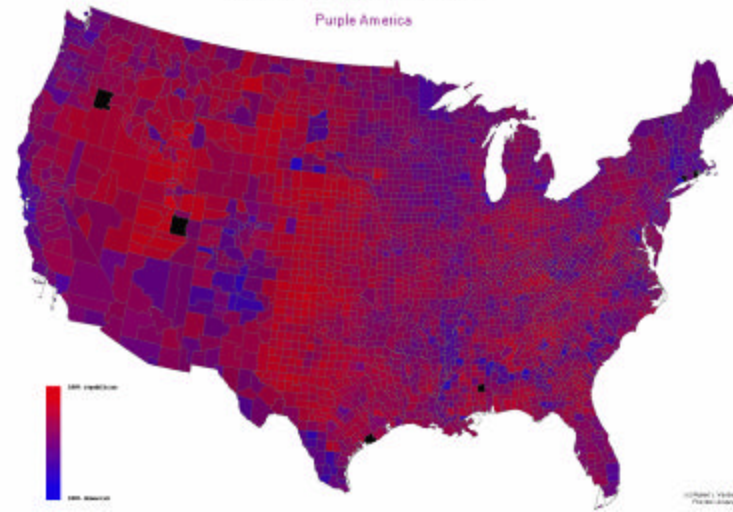


Would you have invested?



2004 Presidential Election

Purple America



The Most Important Thing to Understand About Complex Systems

Linear forcing causes nonlinear responses;
i.e., they undergo phase changes

Looe Key FL 1977



Elliott Norse

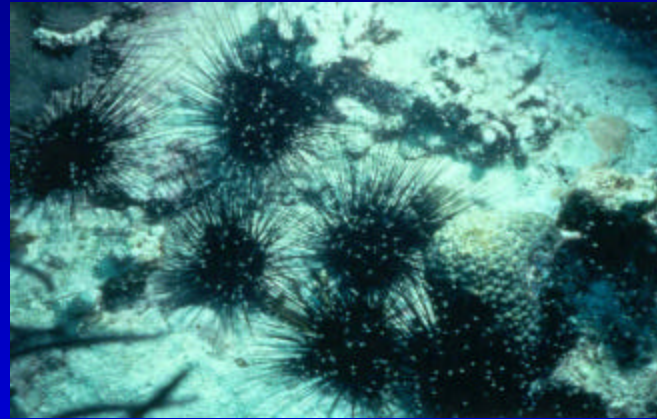
Looe Key FL 2004



Brian LaPoint



J. Jackson (2001) in *Proceedings of the National Academy of Sciences* 98: 5411-5418 explains:



- Western Atlantic coral reefs underwent a dramatic phase shift in the 1980s
- Algae overgrow corals when *Diadema* sea urchins—the last major grazers after large herbivorous fishes were fished out—succumbed to an epidemic

I Celebrate NOAA Fisheries' Intentions to Shift to the Ecosystem Approach



My Best Advice on the Ecosystem Approach

DON'T PANIC!





A journey
of a thousand miles
must begin
with a single step

Lao-Tzu
6th Century BCE

Scientific Consensus on Marine Ecosystem-based Management (2005)

www.compassonline.org

Ecosystem-based management:

- protects ecosystem structure & functioning
- is place-based, focusing on activities affecting specific ecosystems
- maintains species and key services
- acknowledges interconnectedness among systems, e.g., air, land and sea
- integrates ecological, social, economic, and institutional perspectives



To keep every cog and
wheel is the first
precaution to
intelligent tinkering

Aldo Leopold
1887-1948



When the only tool you have
is a hammer,
you tend to treat everything
as if it were a nail

Abraham Maslow
1908-1970

Which Ecosystem Attributes Should We Manage For?

- Composition (species diversity, abundance)
- Spatial structure (habitat complexity)
- Key functions
 - Connectivity
 - Food webs
 - Biogeochemistry



Key Take-home Points (1st Set)

- Ecosystem-based management is not new; people have done it on land for decades
- The goal is to maintain ecosystem integrity and resilience in a changing world
- The perfect is the enemy of the good; phase in ecosystem approaches
- Fisheries depend on the sea's ecosystem goods and services, not vice versa
- No one tool will suffice; use a toolkit

Key Take-home Points (2nd Set)

- The first imperative: keep all the parts
- Keystone predators, ecosystem engineers and structure-formers are crucial
- Endemic and bet-hedging species with high biomass and slow population recovery rates are especially vulnerable
- Solutions will be place-based, focusing on what people do and where
- Start now, learn from mistakes

SHIFTING GEARS

Addressing the Collateral Impacts
of Fishing Methods in U.S. Waters



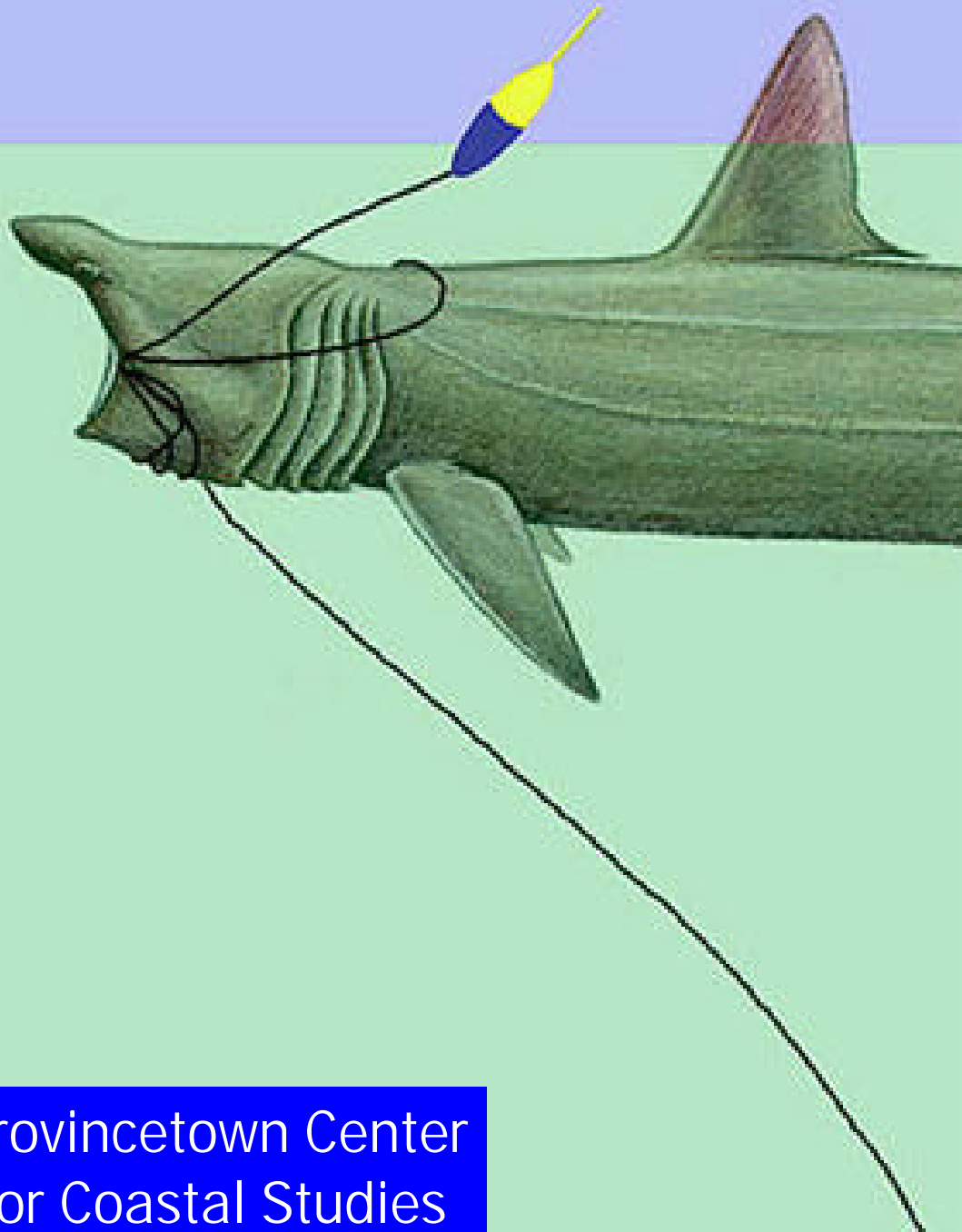
Lance E. Morgan
Ratana Chuenpagdee

PEW
SCIENCE
SERIES

It's not only *how many* fish
are caught that counts;
it's also *how* they're caught

L.E. Morgan &
R. Chuenpagdee (2003)

*Shifting Gears: Addressing
the Collateral Impacts of
Fishing Methods
in U.S. Waters*



A Strong Case for
the Ecosystem
Approach:

Basking Shark
Entanglement

A Strong Case for the Ecosystem Approach: Smalltooth Sawfish Entanglement



Florida Museum of Natural History

A Strong Case for the Ecosystem Approach: Leatherback Sea Turtle Entanglement



Provincetown Center for Coastal Studies



A Strong Case for the
Ecosystem Approach:

Albatross Entanglement

Graham Robertson,
Australian Antarctic Division

A Strong Case for the Ecosystem Approach: Hector's Dolphin Entanglement



Stephen Dawson

A Strong Case for the Ecosystem Approach: North Atlantic Right Whale Entanglement



Provincetown Center for Coastal Studies

Managing Marine Systems is Inherently More Difficult than Managing Land

- The sea is opaque and hostile to humans, limiting direct observation
- Ship time is very expensive, limiting sampling opportunities
- With standard tools it's difficult to trace movements of adults and juveniles, and impossible to trace movements of larvae
- The sea varies markedly in space and time

Even the Simplest Food Webs are Complex

"Classical" Food Web of the North Sea

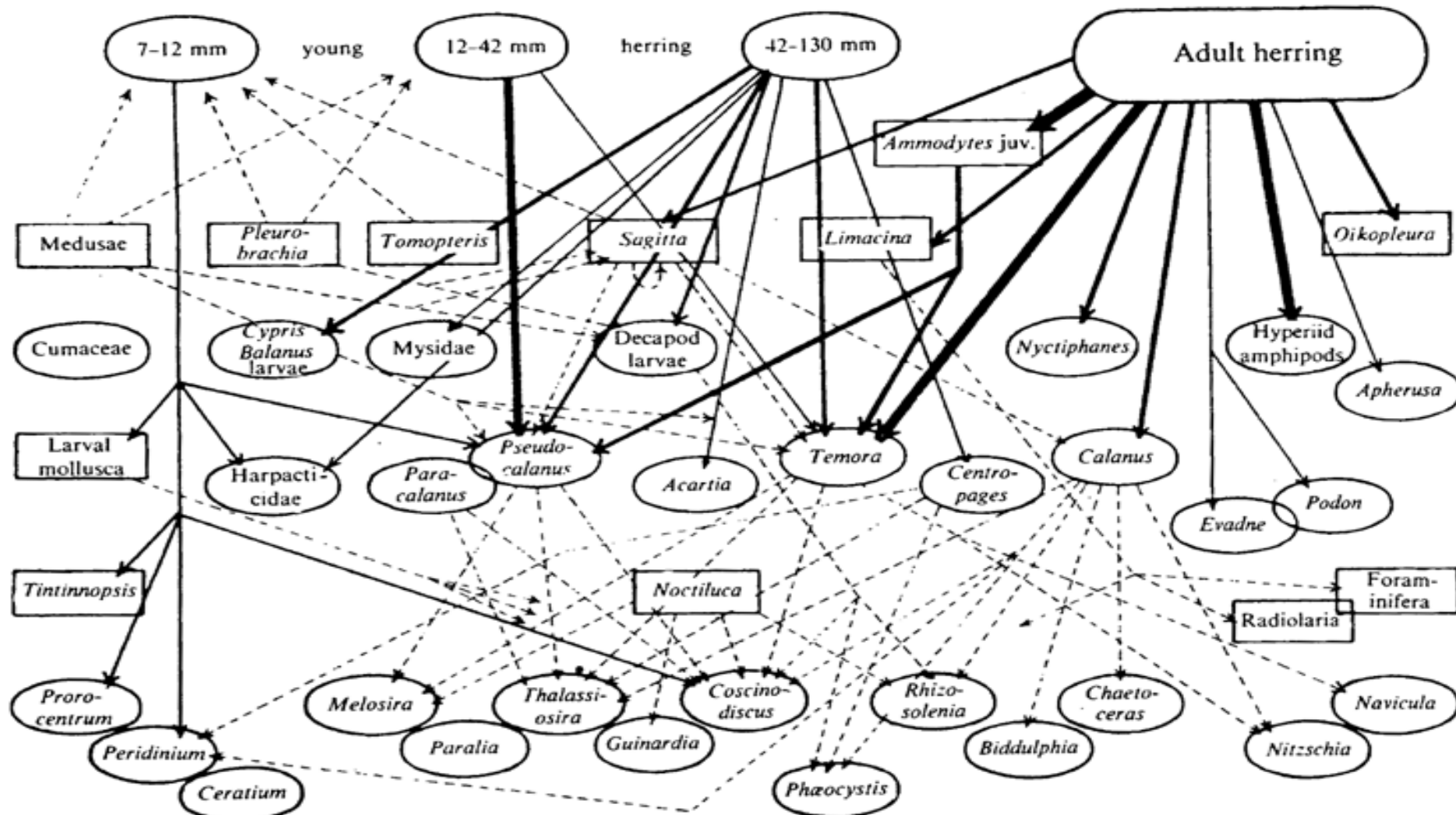


Figure 55. The food web upon which the North Sea herring depends during its life cycle (Hardy, 1924).

It Can Be Difficult to Predict Ecosystem Behavior

- We haven't identified all the components
- We don't know how the components behave under all conditions
- We seldom know causes of tipping points



The Ecosystem Approach Can Require Us to Make Difficult Choices



And *Most of All*

- Ecosystem-based management is about managing an unruly species



Biologists Alone Aren't Enough

- Understanding population dynamics and food webs is not sufficient
- Most of us have little or no formal training in understanding or managing people
- Ecosystem-based management must integrate natural and social sciences

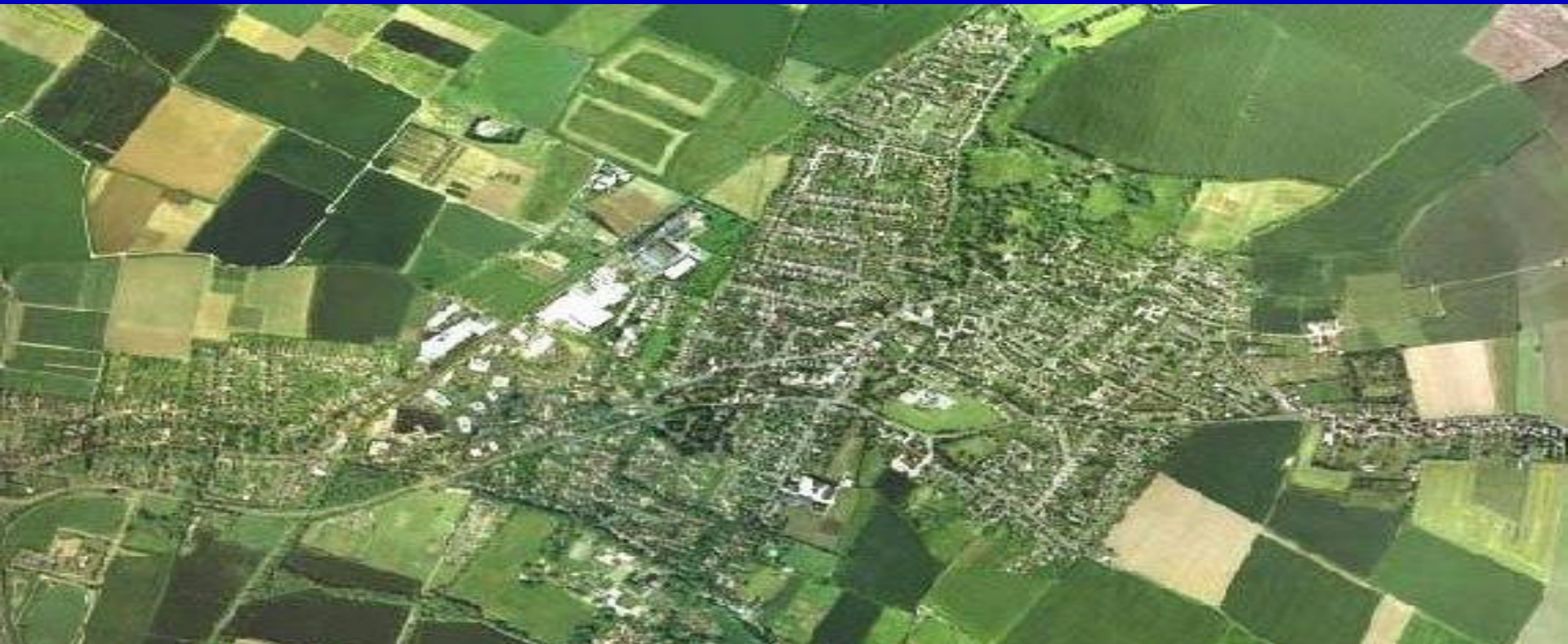




Marine ecosystem-
based management
will develop in phases
over decades, but
there are key steps
we can take *now*

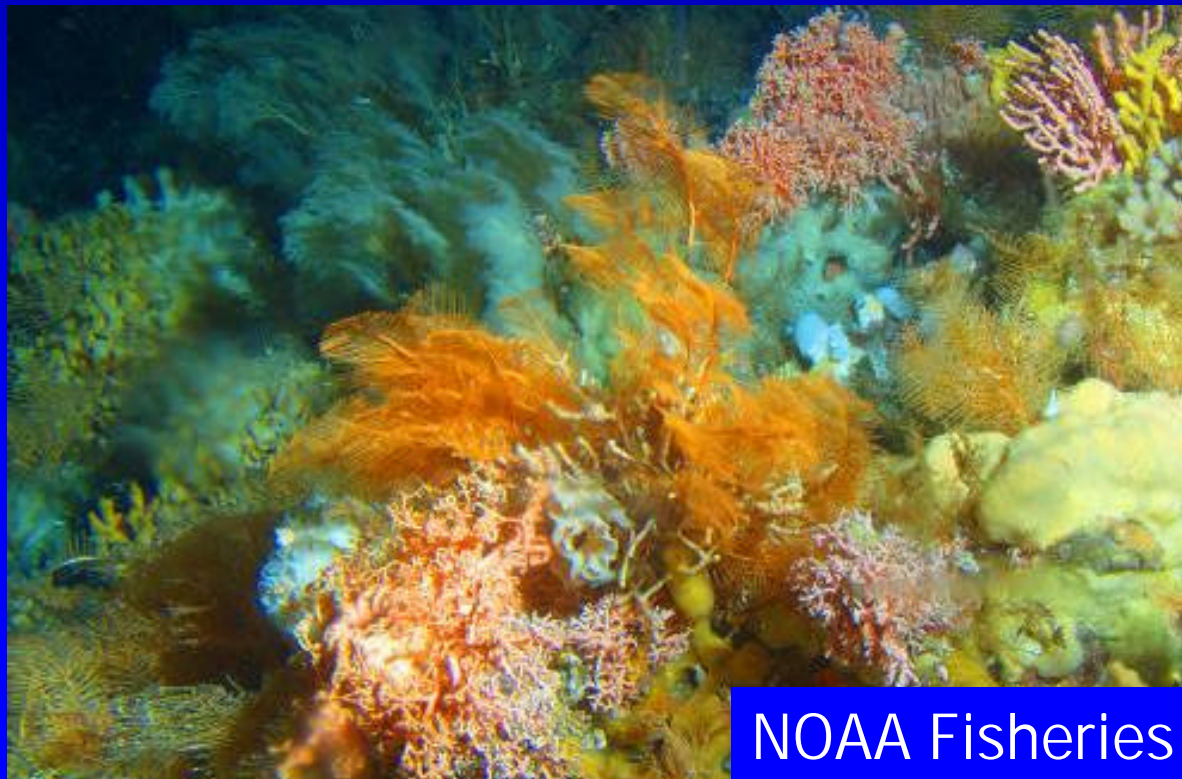
We Can Use Zoning

Definition: A place-based ecosystem management system that reduces conflict, uncertainty and costs by separating incompatible uses and specifying how particular areas may be used



Benefits of Zoning

- It dramatically reduces the pernicious effects of open-access competition
- It addresses the sea's heterogeneity



NOAA Fisheries

2 Ways to Zone

1) **Piecemeal**, by placing zones in certain places for certain purposes without regard to others



or



2) **Comprehensively**, by assembling zones throughout an area by considering all acceptable uses

Reef and Non Reef Bioregions in the Great Barrier Reef World Heritage Area



Insufficient information to determine bioregion type

- ?? Far North Offshelf
- ??2 Offshore Old Trough
- ??27 Far North Outer Reefs
- ??21 Cap Bunk Reefs
- ??24 Outer Central Reefs
- ??25 Central Offshelf
- ??28 Central Reefs
- ??28 Southern Embayment

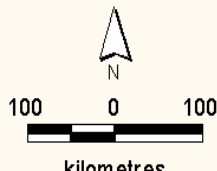
Caution
The bioregions shown on this map were defined by marine experts who, together have over 20 years of experience in the GBR region and who used the best available data and regional analysis as collected by GBRMPA in 1999. As new information and expertise are developed it is expected that the boundaries of these bioregions can be improved and updated. In this way these bioregions are not definitive or a complete description of the marine diversity within the GBRWHA.

Reef bioregions

- RA1 Bellie Reefs
- RA2 Outer Barrier Reefs
- RA3 Outer Shelf Reefs
- RA4 Strong Tidal Outer Shelf Reefs
- RA1 Far Northern Outer Mid Shelf Reefs
- RA1 Torres Strait Influenced Mid Shelf Reefs
- RA2 Far Northern Protected Mid Shelf Reefs
- RA1 Capricorn Bunker Outer Reefs
- RA2 Capricorn Bunker Mid Shelf Reefs
- RA3 Far Northern Open Lagoon Reefs
- RA1 Coastal Far Northern Reefs
- RA2 Coastal Northern Reefs
- RA3 Coastal Central Reefs
- RA4 Coastal Southern Reefs
- RA5 Coastal Strong Tidal Reefs
- RA6 Inland Reefs
- RA7 Tidal Mud Flats
- RA8 Coastal Southern Fringing Reefs
- RA1 Northern Open Lagoon
- RA2 Central Open Lagoon
- RA3 Southern Open Lagoon
- RA1 Protected Mid Shelf Reefs
- RA2 Exposed Mid Shelf Reefs
- RA Strong Tidal Mid Shelf Reefs
- RA High Continental Islands
- RA Low Line Reefs
- RA High Tidal Island Fringing Reefs
- RA Inner Mid Strong Tidal Reefs
- RA Outer Mid Reefs
- RA Outer Mid Reefs - Northern Reefs

Non reef bioregions

- NA1 Coastal Strip - Coral Sand
- NA2 Coastal Strip - Mud
- NA3 High Nutrient Coastal Strip
- NA4 Inshore Terrigenous Sands
- NA1 Inshore Muddy Lagoons
- NA2 Inshore Lagoons
- NA3 Inner Shelf Seagrass
- NA4 Inner Shelf - Calms
- NA5 Inner Mid Shelf Lagoons
- NA6 Inner Shelf Lagoons - Continental Shelves
- NA7 Mid Shelf Lagoons
- NA8 Capricorn Bunker Lagoons
- NA9 Mid Shelf Inner Reef - Seagrass
- NA10 Mid Shelf Inner Reef
- NA11 Outer Shelf Lagoons
- NA12 Halimeda Banks - Some Coral
- NA13 Mid Shelf Sandy Reefs
- NA14 Halimeda Banks
- NA15 Princess Charlotte Bay Outer Shelf
- NA16 Princess Charlotte Bay
- NA17 Outer Shelf Algae and Seagrass
- NA18 Outer Shelf Seagrass
- NA19 Outer Shelf Inner Reef - Central
- NA20 Outer Shelf Inner Reef - Southern
- NA21 Swains Inner Reef
- NA22 Mid Shelf Seagrass
- NA23 Capricorn Bunker Banks
- NA24 Capricorn Trough
- NA25 Eastern Plateau
- NA26 Steep Slope
- NA27 Green Sand Trough
- NA28 Intermediate Broad Slope
- NA29 Pelagic Platform
- NA30 Terraces



In rezoning Great Barrier Reef Marine Park, experts identified 70 ecosystem types or "bioregions" (30 reef, 40 non-reef)

GBRMP Rezoning was Based on Key Principles:



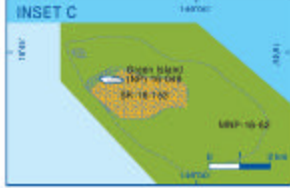
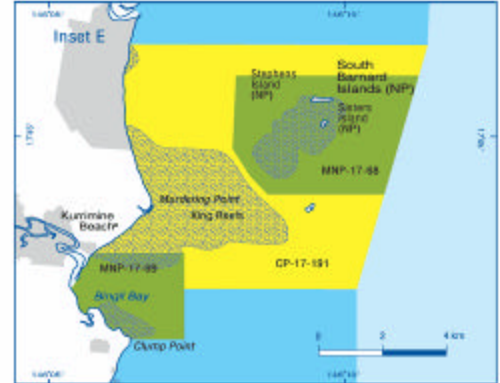
GREAT BARRIER REEF
MARINE PARK AUTHORITY

- Protecting the resource comes **first**; all uses must be compatible with conservation goals
- Protect a minimum of 20% per ecosystem type in no-take areas
- Represent **the full range** of plant and animal diversity, from north to south *and* from inshore to offshore
- Have ample **public participation** in the decision

- Legend**
- Reef Flat or Seamount (Rock)
 - Submerged Reef
 - Indicative Reef Boundary
 - Coastline
 - Water
 - Reefshore Flat (Saline Coastal Flat)
 - Mangrove
 - Population Centres (To Scale) (Symbolised)
 - Major Road (Minor Road (Dashed or Unshown))
 - National Park/Conservation Tenure
 - Great Barrier Reef Region Boundary
 - Great Barrier Reef Marine Park Management Area Boundary

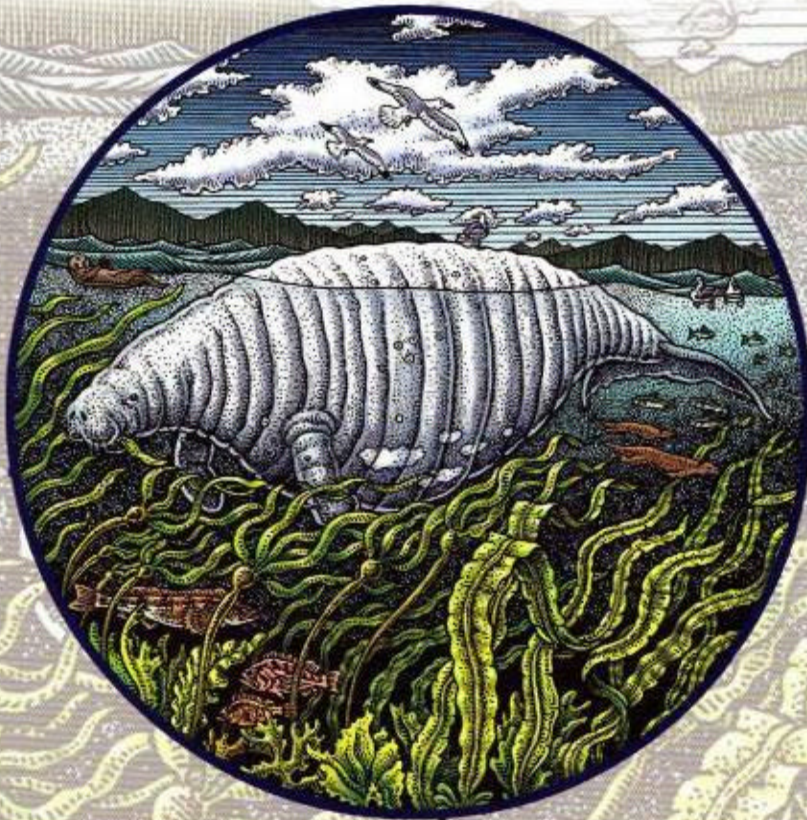


Great Barrier Reef Marine Park Zoning Map



Marine Conservation Biology

THE SCIENCE OF MAINTAINING THE SEA'S BIODIVERSITY



Edited by Elliott A. Norse and Larry B. Crowder

Foreword by Michael E. Soulé

Marine Conservation Biology Institute

E.A. Norse (2005).
Ending the range wars
on the last frontier:
Zoning the sea

E.A. Norse &
L.B. Crowder
*Marine Conservation
Biology:
The Science of
Maintaining the Sea's
Biodiversity*

What Can NOAA Fisheries Do for Starters?

- Recognize that fishing is only *one* important value of oceans, and embrace use of no-take reserves and zones that limit destructive fishing gears
- Cooperate with other parts of NOAA that already use the place-based approach
- Work to reduce influence of Fishery Management Councils in conservation decision making

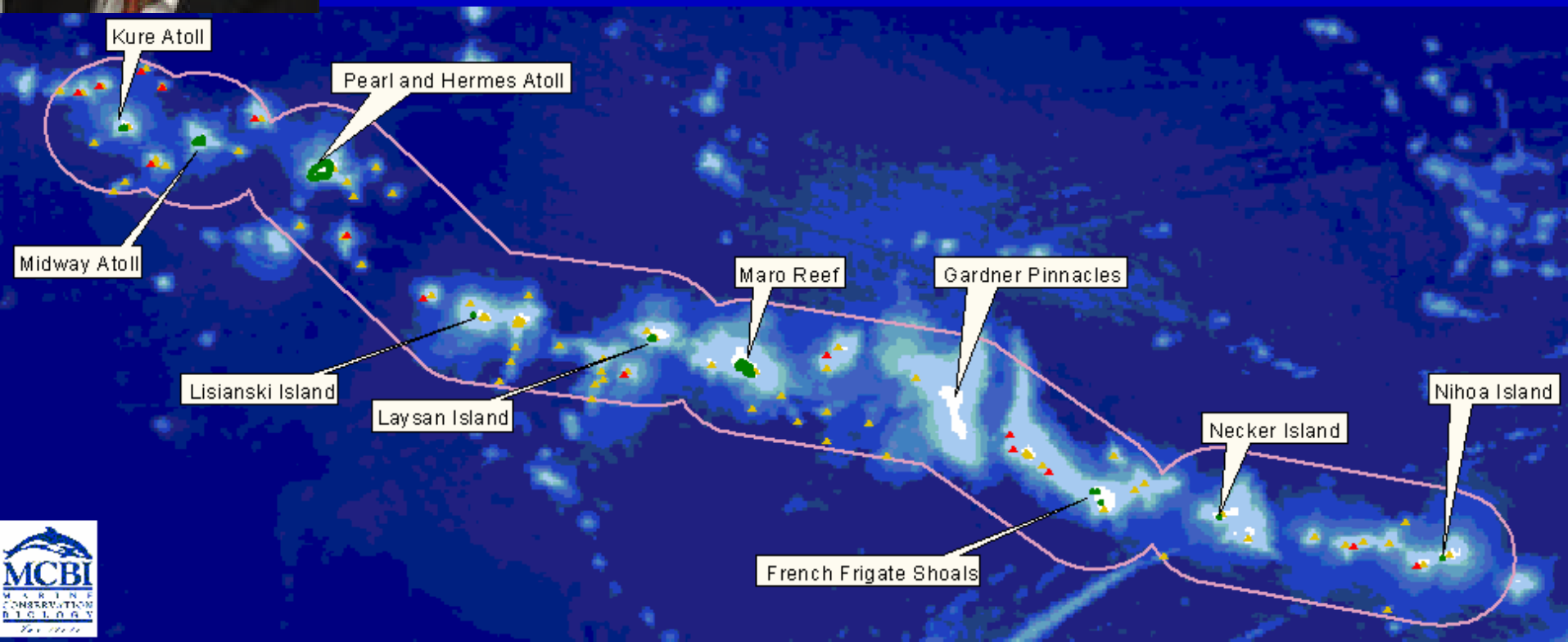
Remove Ecosystem Decisions from *Financially Interested Interests*

- Support establishment of an independent federal panel of scientists who would set conservation goals and objectives using the ecosystem approach, and establishment of regional ecosystem management councils to make all conservation decisions
- Removing conflict-of-interest would allow NOAA Fisheries to recover America's fisheries, protected species and marine ecosystems

Make History by Supporting *Full Protection* of the NW Hawaiian islands



The Bush Administration and Governor Lingle want the NWHI to be a no-take National Marine Sanctuary



Partner with People *Other than Fishermen* Who Understand the Sea

I invite NOAA Fisheries to sponsor MCBI's
Mia J. Tegner Grants in Marine Environmental
History and Historical Marine Ecology

These fund studies of the past to help managers
set sound population and ecosystem targets

(e.g., J. Roman and S.R. Palumbi (2003)
Whales before whaling in the
North Atlantic. *Science* 301: 508-510



Let's Restore America's Marine Ecosystems!





www.mcbi.org